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A Structure for Capturing Quantitative Benefits from the Transfer of Space and Aeronautics Technology

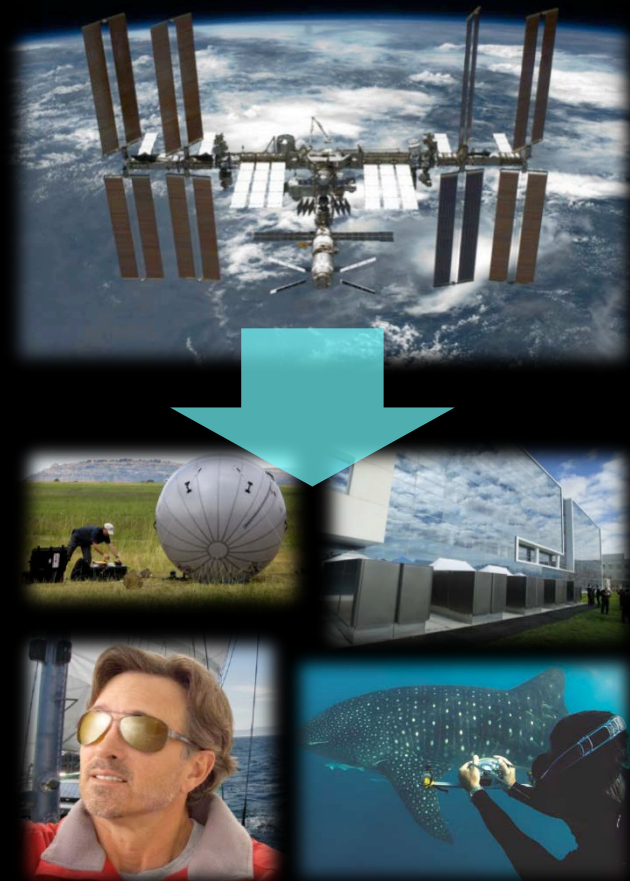


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NASA Technology Transfer

- ❖ A primary objective noted in the 2011 NASA Strategic Plan: to “drive advances in science, technology, and exploration to enhance knowledge, education, innovation, economic vitality, and stewardship of Earth”
- ❖ The 1958 Aeronautics and Space Act that created NASA mandated that the Agency transfer its technologies “for the benefit of all mankind”
- ❖ In addition to enabling missions to the stars, NASA R&D produces ancillary benefits to the government, economy, and general public that are visible in our everyday lives, from the grocery store to the hospital



The Spinoff Publication

- ❖ Since 1976, NASA has generated anecdotal evidence of benefits using its annual *Spinoff* publication
 - Serves as a tool to educate the media and general public about the benefits of NASA research
 - Fulfills the reporting requirement outlined in the 1958 Space Act
 - Positive results of tech transfer resonate with public, demonstrating tangible benefits from the Nation's investment in space and aeronautics



With over 1,750 recorded NASA spinoffs, NASA technologies influence our lives in a variety of ways—making us safer, healthier, and more efficient.



Prior Studies of NASA's Economic Benefit

- ❖ Many attempts have been made to examine the economic benefits of NASA technologies
 - Studies have indicated discounted rates of return from 33% to 43% and include ratios from a 7 to 23.4 multiplier effect
 - Each study has independent value, but there is no consistent, coherent, standardized analytic framework for characterizing benefits
 - Benefits are often characterized anecdotally
- ❖ For consistent, coherent, sustainable data collection, a common set of analytic categories must be developed, and reporting standardized



Significant NASA Tech Transfer Studies

Study	Methodology	Quantitative Findings	Limitations
Mathematica, 1976	Case studies of four major NASA technology categories	<ul style="list-style-type: none"> • Cryogenics: \$1B • Integrated Circuits: \$5B • Gas Turbines: \$111M • NASTRAN: \$701M <p>(all estimated benefits)</p>	<ul style="list-style-type: none"> • Small data set • Not sustainable • Dated • Restricted to revenue generation • Forward-looking projections of future benefit
Chapman Research Group, 1989	<ul style="list-style-type: none"> • Examination of 259 published <i>Spinoff</i> articles • Telephone interviews and inquiries 	<ul style="list-style-type: none"> • \$2.13B NASA contributions to sales • \$315.7M NASA contributions to cost savings • 325,000 jobs created/saved • \$365M in tax receipts 	<ul style="list-style-type: none"> • Data set restricted to NASA <i>Spinoff</i> companies • Restricted to revenue from sales and cost savings
Chapman Research Group, 1993	<ul style="list-style-type: none"> • Examination of 353 published <i>Spinoff</i> articles • Telephone interviews and inquiries • Continuation of 1989 Chapman Report 	<ul style="list-style-type: none"> • \$32B NASA contribution to sales • \$1B NASA contribution to cost savings 	<ul style="list-style-type: none"> • Data set restricted to NASA <i>Spinoff</i> companies • Not repeated • Restricted to revenue generated and cost savings
Hertzfeld, 1997	<ul style="list-style-type: none"> • Surveys • Telephone Interviews and inquiries • Literature review • Case studies 	Over \$1.5B in value added to 15 NASA life sciences partner firms	<ul style="list-style-type: none"> • Small dataset, restricted to 15 program-specific technologies • Difficulty collecting data, survey responses • Not repeated

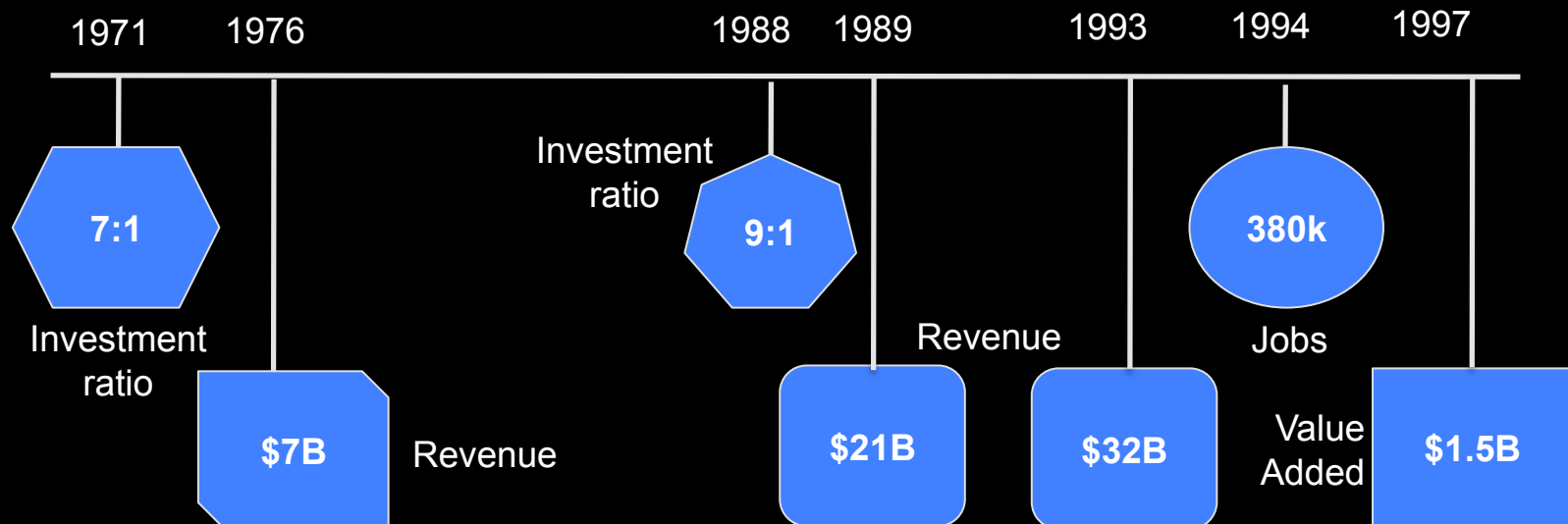
Additional Relevant Studies

Study	Methodology	Quantitative Findings	Limitations
Midwest Research Institute, 1971	Macroeconomic projections	<ul style="list-style-type: none"> • Average 7:1 rate of economic return on each dollar invested in NASA • Discounted rate of return on NASA investments of approximately 33% 	Limited to ratios of R&D expenses to national economic gains
Chase Econometric Associates, 1976	Simulations and modeling	<ul style="list-style-type: none"> • Average 7:1 rate of economic return on each dollar invested in NASA • Historical rate of return from NASA R&D spending of 43% 	Focused solely on economic forecasting and projections using theoretical increases and decreases in NASA funding
Midwest Research Institute, 1988	Macroeconomic projections	<ul style="list-style-type: none"> • Average 9:1 rate of economic return on each dollar invested in NASA • Discounted rate of return on NASA investments ranging between 19 and 35% 	Limited to ratios of R&D expenses to national economic gains
The WEFA Group, 1994	Economic modeling	<ul style="list-style-type: none"> • Estimated 380,000 NASA-generated jobs by 1997 • \$153.5B in GDP generated by NASA-related activity by 2000 	<ul style="list-style-type: none"> • Restricted to job growth • Restricted to human spaceflight and ISS

Common Conclusions

- ❖ NASA R&D yields tangible and economic benefit in addition to the meeting of mission goals
- ❖ NASA should develop a sustainable approach to gathering this information

Historical Quantification Efforts



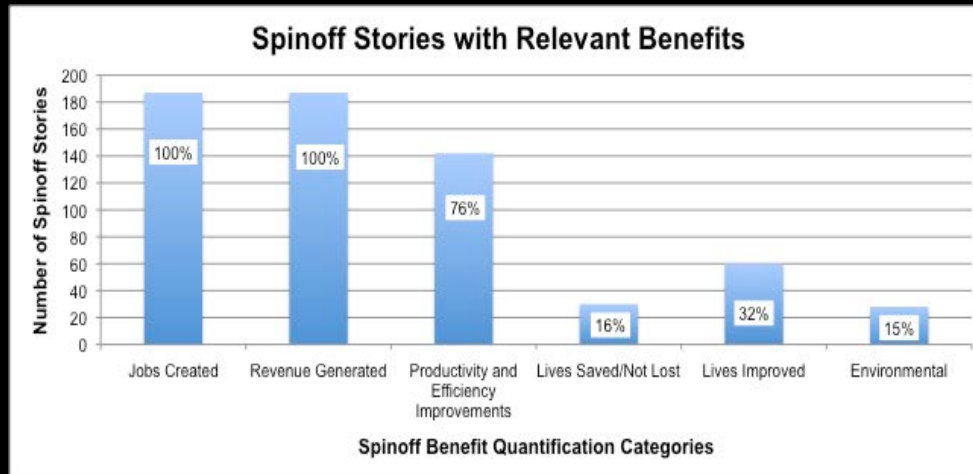
- ❖ **Impressive results** from these individual efforts, but
- Inconsistent assumptions and measures
 - Irregular occurrence
 - Not sustainable
 - Difficult to aggregate

Establishing Standardized Quantification Categories

- ❖ 187 Spinoff articles from 2007–2010 were examined, leading to the initial identification of five categories of benefit:
 - Jobs Created (number of jobs)
 - Revenue Generated (dollars)
 - Productivity and Efficiency Improvements (dollars)
 - Lives Saved/Not Lost (number of individuals)
 - Lives Improved (number of individuals)
- ❖ To assess the efficacy of the quantification categories, a thorough examination of the 187 Spinoff articles was conducted
- ❖ The five categories were confirmed as providing good capture of representative benefits across a wide range of *Spinoff* stories

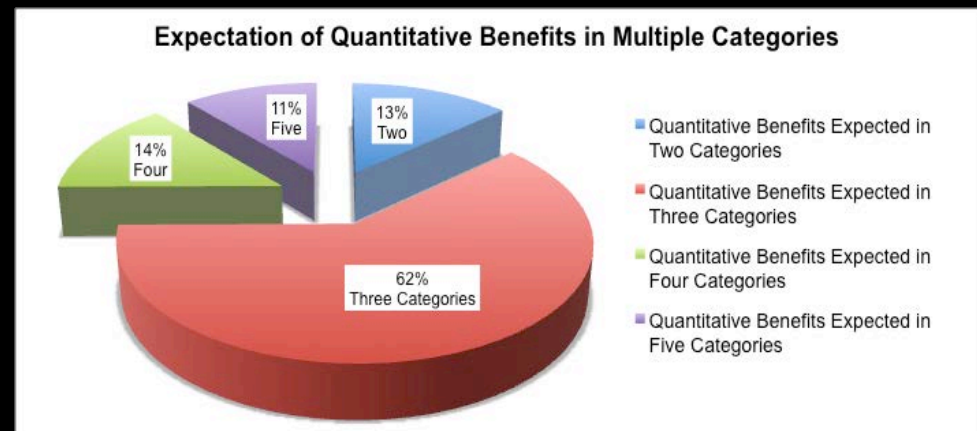


Spinoff Analysis Results



Spinoff articles from 2007–2010 were analyzed to identify the percentage that would be expected to have quantitative benefits in each of several different candidate quantification categories

A majority of the articles examined were expected to show quantitative benefits in multiple categories



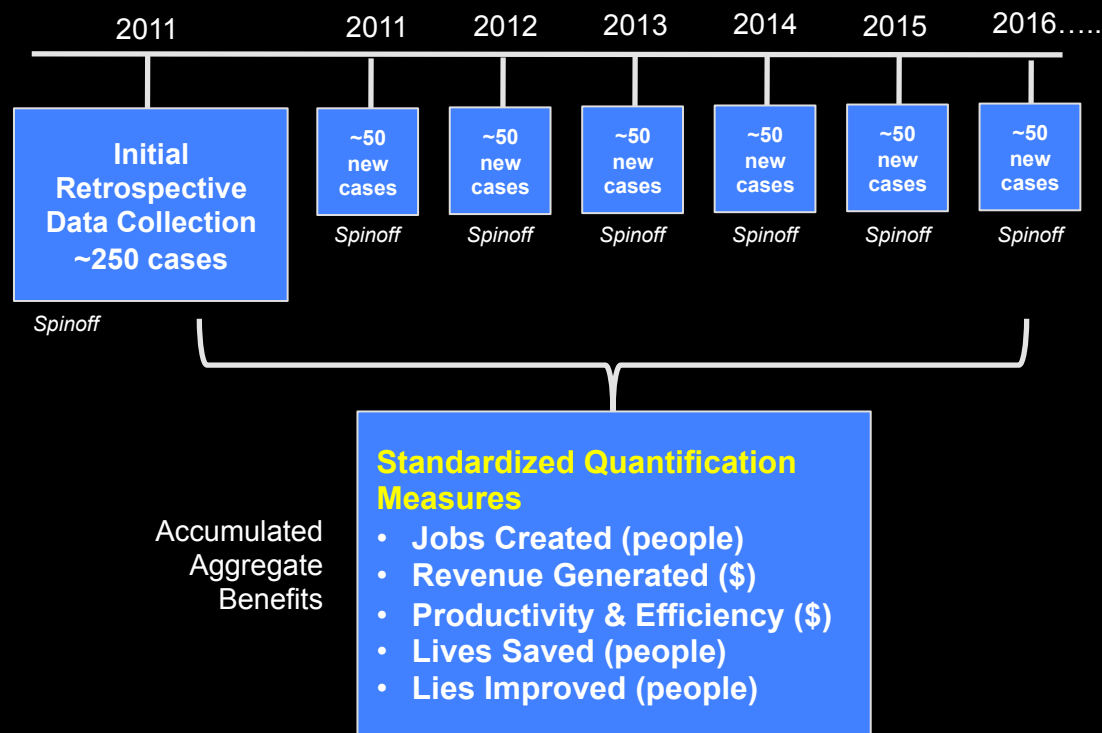
Spinoff Analysis Results

While the availability of published data in these quantification categories is low, the aggregate benefit numbers they represent is impressive.

	Jobs Created	Increased Revenue	Productivity and Efficiency Improvements	Lives Saved/Not Lost	Lives Improved
	1,665	\$532M	\$4.13B	695	30M
Percentage of Companies	4%	5%	2%	1%	2%



Structured Collection of Quantitative Benefits



- ❖ Structured Data Collection Process will yield:
- Standardized measures
 - Consistent assumptions
 - Traceable data
 - Sustainable through annual Spinoff process
 - Easy to aggregate over time

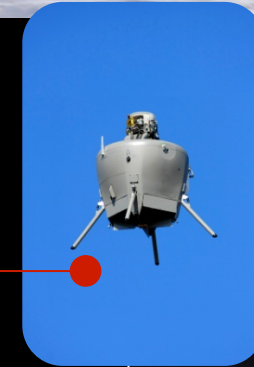
Jobs Created

- ❖ Of the 250 companies polled, the 75 companies who provided data reported the creation of more than 9,200 jobs.
- ❖ An additional 19 companies reported that no jobs were created by the use of NASA technology.
- ❖ It is a somewhat subjective process to determine whether an employee's job would have existed if the company did not produce a NASA spinoff
 - The number of jobs created will have to be a determination made by each individual company based upon their own unique analysis
 - NASA can perform a reasonableness assessment based on the company's information
 - The best and most appropriate source of jobs created data is the companies themselves



Jobs Created Through NASA Tech Transfer

- ❖ Of the over 9,200 jobs reported due to recent NASA technology transfer efforts, the following subset shows some highlights:
 - NVision Solutions Inc. of Mississippi: 73 jobs
 - Mikro Systems Inc. of Virginia: 37 jobs
 - Aurora Flight Sciences Corporation of Virginia: 510 jobs
 - AlterG Inc. of California: 65 jobs
 - Martek Biosciences of Maryland: 500+ jobs
 - Bloom Energy of California: In the process of adding 1,000 jobs
 - Sierra Lobo Inc. of Ohio: 400 jobs
 - GATR Technologies of Alabama: 20 jobs



Jobs Created

Goddard Space Flight Center

Aurora Flight Sciences Corporation Manassas, Virginia

NASA Technology

- ❖ NASA and the Massachusetts Institute of Technology collaborated on the Daedalus project, exploring new technologies for lightweight aircraft and high-altitude, long-duration flight
- ❖ Aurora was founded out of that effort and began a pattern of partnership with NASA

Partnership

- ❖ The company has engaged in numerous Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) projects
- ❖ A Space Act Agreement (SAA) with Goddard resulted in manufacturing techniques used to produce composite airframe components for the Global Hawk UAV, used by the military and NASA

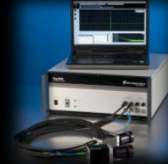
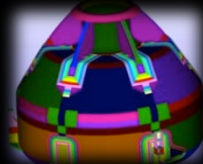


Benefits

- ❖ The SAA allowed Aurora to open a facility in West Virginia now employing 160 workers; the company has 350 employees at facilities in four states
- ❖ The company produces all of the Global Hawk airframe components, save for the wings
- ❖ Aurora also manufactures cutting-edge UAV designs for military surveillance applications

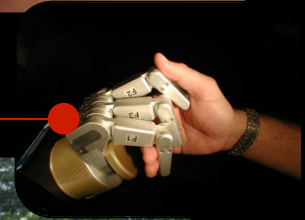
Revenue Generated

- ❖ Of the 250 companies polled, 83 provided revenue figures attributable to NASA, with a total of over **\$1.2 billion**
- ❖ Ten companies reported no gains in revenue
- ❖ If the company is based solely on the spinoff, then the revenue determination is easy (total company revenues); if not, separating revenues may require unique analysis
 - Ensuring consistency in data collected is a challenge
 - Single-year revenue could underestimate total lifetime revenue generated; estimates of future revenue could result in overstatement



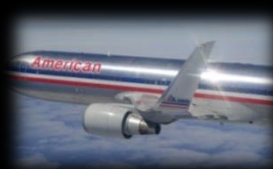
Revenue Generated Through NASA Tech Transfer

- ❖ Over **\$1.2 billion** in revenue has been reported due to recent NASA technology transfer.
- ❖ These highlights are some of the successes:
 - NVision Solutions Inc. of Mississippi: **\$2.5 million**
 - BRS Aerospace of Minnesota: about **\$20 million** for 2010 alone
 - SpaceForm Inc. of Michigan: **\$6 million**
 - SpaceMicro of California: grew from a \$1 million company to a **\$8 million** company
 - Martek Biosciences Corporation of Maryland: **\$450 million** per year
 - Recently acquired by DSM Inc. for **\$1.1 billion** (not included in total)
 - Barrett Technology Inc. of Massachusetts: **\$10 million**
 - LifeWings Partners of Tennessee: **\$3 million** per year
 - GATR Technologies of Alabama: **\$8.6 million**
 - Amnis Corporation of Washington: **\$10 million**



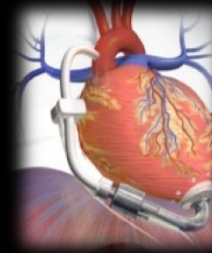
Productivity and Efficiency Improvements

- ❖ Of the 250 companies surveyed, 45 companies said that they experienced no efficiency improvements that could be expressed as dollars, while 46 did achieve cost avoidance totaling over **\$6.2 billion**.
- ❖ Placing a dollar amount on the amount of time and money saved by using or producing the spinoff technology can be a difficult task
 - There is no standard approach to calculating productivity and efficiency improvement benefits; each company must apply its own judgment and analysis to develop an appropriate estimate
 - Company-provided data should be viewed as “reasonable estimates”; NASA should conduct reasonableness assessments of the information



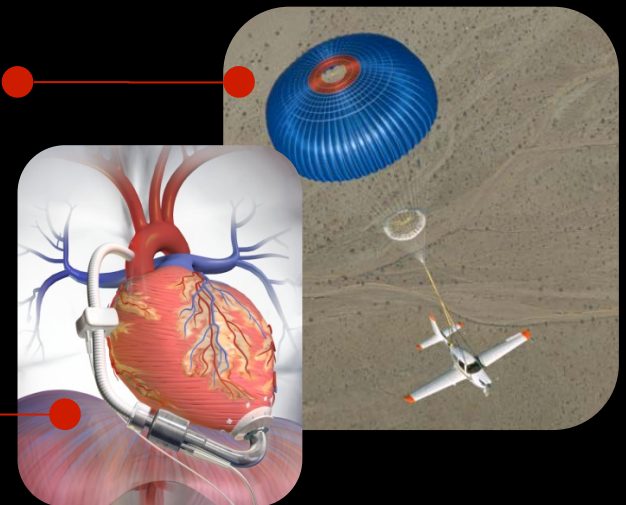
Lives Saved or Improved

- ❖ Of the 250 companies surveyed, 53 said that their technology had not saved any lives, while 20 companies reported that their technologies had indeed saved lives, over **12,000** of them.
- ❖ Of the 250 companies polled, 18 reported improving or enhancing lives, while 53 again said that this category did not apply to their spinoff product.
- ❖ Of the companies who did respond in the affirmative, the total lives improved or enhanced was over **86 million**.



Lives Saved as a Result of NASA Technology Transfer

- ❖ Of the over **12,000** lives saved as a direct result of NASA technology transfer (17 companies contributed to this total), these are but a few examples:
 - Advanced Circulatory Systems Inc. of Minnesota: CPR assist devices provide up to a **57-percent** increase in the survival rate of heart attack victims
 - Givens Marine Survival Company of Rhode Island: Specialized life rafts have saved the lives of **400+** sailors to date
 - BRS Aerospace of Minnesota: Whole plane parachutes have saved the lives of **265** pilots and passengers to date
 - LifeWings Partners of Tennessee: Operational training in hospitals has resulted in an almost **50-percent** drop in observed to expected deaths
 - MicroMed Technology Inc. of Texas: **450+** patients have received life-saving heart pumps, accounting for **130+** patient years of life



NASA Technology: Improving Our Lives



Advanced Diagnostic
Ultrasound in
Microgravity



LED Light Therapy For Pain
Management



Groundwater Remediation



Clean Energy



Winglets Save Fuel
Cost



Lithium Batteries for Cars



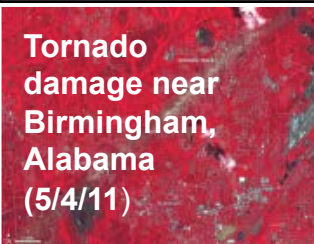
Aerogel Insulation



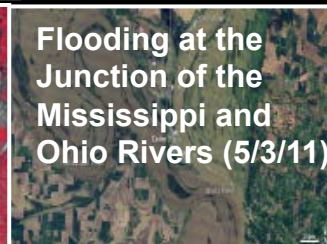
Eye Exams



Infrared Thermometers



Tornado
damage near
Birmingham,
Alabama
(5/4/11)



Flooding at the
Junction of the
Mississippi and
Ohio Rivers (5/3/11)

Weather Forecasting



Nutritional Supplements



A 2011 survey (85 respondents) of the 250 tech transfer successes reported over the past five years revealed that commercialized NASA technologies have:

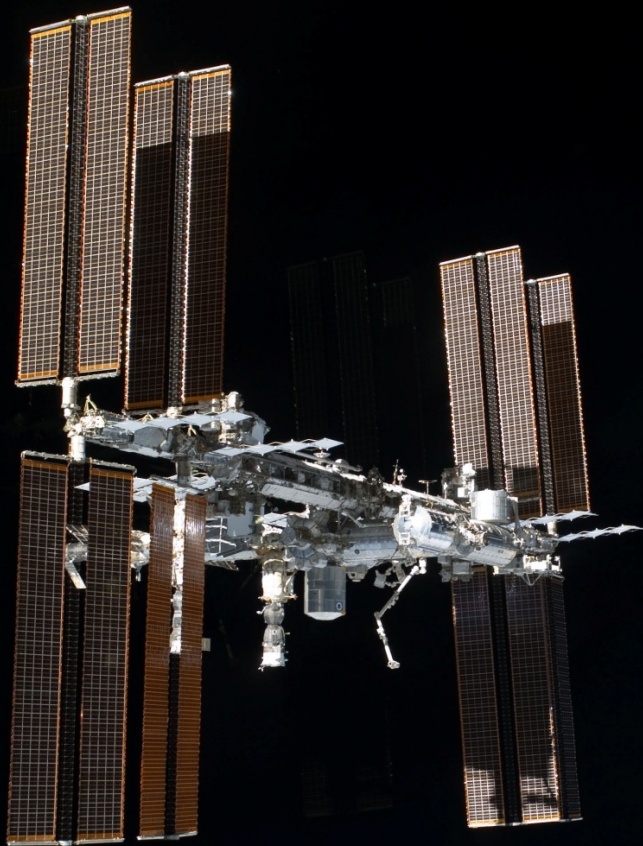
- Created over 9,200 jobs
- Generated over \$1.2B in revenue
- Created than \$6B in cost avoidance
- Saved more than 12,000 lives
- Significantly improved quality of life for more than 86 million people



Conclusions

- ❖ NASA will continue to develop sustainable ways to gather and interpret quantifiable benefits data
 - Spinoff writers will now routinely survey companies interviewed and collect quantifiable data in the standard categories
 - Data will supplement the existing qualitative data, not replace it
 - Methodologies and results should be placed in context
 - Not a comprehensive portrayal of NASA's technology transfer activities
 - NASA does not have the resources to rigorously validate all benefit data
 - Technical personnel at the NASA field centers will provide reasonableness assessments on the information
- ❖ Future data gathering could be aided by the inclusion of requirements in patent licensing documentation or SBIR contracts, requiring partner companies to report back on successes

NASA Technology Transfer Resources



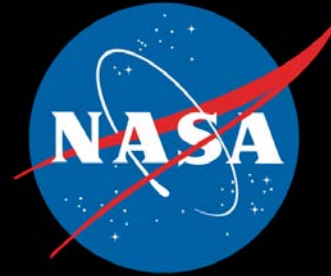
Office of the Chief Technologist
www.nasa.gov/offices/oct/home/index.html

Innovative Partnerships Office
www.nasa.gov/offices/oct/partnership/index.html

NASA Online Partnering Tool
<http://octpartneringtool.nasa.gov>

NASA *Spinoff*
<http://spinoff.nasa.gov>

NASA @ Home and City
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